ECHO LAKE

REPORT DESCRIPTION

This report is an update on the health of Echo Lake based on water quality data collected from 1992 through 2015 by local volunteers and Snohomish County Surface Water Management (SWM) staff. For additional background on the information provided here or to find out more about Echo Lake, please visit www.lakes.surfacewater.info or call SWM at 425-388-3464.

LAKE DESCRIPTION

Echo Lake is a 21.5 acre lake located about four miles southeast of Maltby. It is spring-fed, and the outlet drains west to Bear Creek. Echo Lake is relatively deep for its size, with a maximum depth of 15 meters (49 feet) and an average depth of 5.2 meters (17 feet).

The lake watershed, which is the land area that drains to the lake, is small—only 7 times the size of the lake. This means that there is less potential for watershed pollution to affect the lake. However, Echo Lake is located in one of the fastest growing areas in the county. Therefore, the water quality impacts from future growth are a potential concern for Echo Lake.

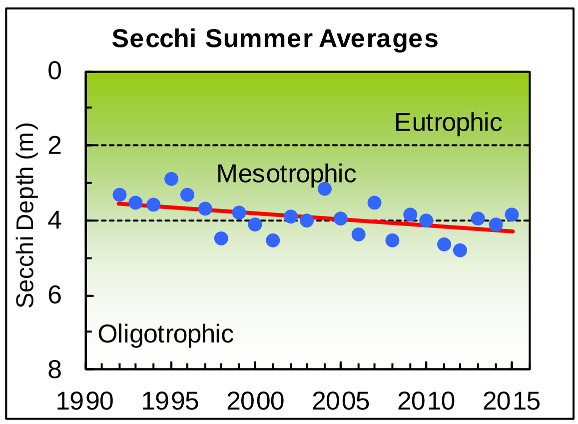
LAKE CONDITIONS

The following graphs illustrate the summer averages and trend lines (in red) for water clarity, total phosphorus, and chlorophyll *a* for Echo Lake. Please refer to the table at the end of this report for long-term averages and for averages and ranges for individual years.

Water Clarity

The water clarity of a lake, measured with a Secchi disk, is a reading of how far one can see into the water. Water clarity is affected by the amount of algae and sediment in the lake, as well as by water color. Lakes with high water clarity usually have low amounts of algae, while lakes with poor water clarity often have excessive amounts of algae.

The water clarity in Echo Lake is moderate to high, with a long-term summer average of 3.9 meters (12.8 feet). Between 1992 and 2015, there has been a statistically significant trend toward improving water clarity in the lake (p=0.01). However, as discussed below, the trend toward improved water clarity is at odds with the trend toward increasing phosphorus in the upper waters and the higher chlorophyll *a* averages in some years. It is possible that changes in the amount of natural water color may be affecting measurements of water clarity.



Water Color

The color of lake water affects water clarity and the depths at which algae and plants can grow. In many lakes, the water is naturally brown, orange, or yellow. This darker color comes from dissolved humic compounds from surrounding wetlands and does not harm water quality. Measurements of true water color provide clues to changes in water clarity. True water color is only the color from dissolved materials and not of the color of algae or sediment suspended in the water.

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The water color of Echo Lake averaged 16 pcu (platinum-cobalt color units) in 2010 - 2011, which indicates a slight to moderate amount of color in the lake water. This means that the lake water color is not as dark as in 1994 – 1995 when the average was 20 pcu. This reduction in color may be playing a role in the increased water clarity over the same time period.

Temperature

The temperature of lake water changes with the seasons and varies with depth. During spring and summer, the sun warms the upper waters. Because warmer water is less dense, it floats above the cooler, denser water below. The temperature and density differences create distinct layers of water in the lake, and these layers do not mix easily. This process is called stratification and occurs during the warm months. The warm, upper water layer is called the epilimnion. The colder, darker bottom zone is called the hypolimnion. These layers will stay separated until the fall when the upper waters cool, the temperature differences decrease, and the entire lake mixes, or turns over.

Beginning in May 2015, temperature data were collected at each meter throughout the Echo Lake water column. These profiles are similar to previous years and show that the lake was strongly thermally stratified throughout the summer. This means that there was a large temperature difference between the warm upper waters and the cool bottom waters, and mixing did not occur between these layers. In May, the upper waters measured about 62˚F (17°C) in temperature, and by July, had reached their peak at 77°F (25°C). At the same time, bottom water temperatures changed very little and remained around 44-46°F (6-7°C). By October, the surface waters had partially cooled. Through the fall, the cooling will continue until the temperatures are almost equal from top to bottom. As stratification weakens, the lake water will turn over (or mix). The lake will stay mixed during the winter until springtime, when the upper waters began to warm again.

Dissolved Oxygen

Oxygen dissolved in the water is essential for life in a lake. Most of the dissolved oxygen comes from the atmosphere. Like temperature, dissolved oxygen levels vary over time and with depth. During the warm months, the upper waters receive oxygen from the atmosphere, but the lower waters cannot be replenished with oxygen because of the separation between water layers. Meanwhile, bacteria in the lake bottom are consuming oxygen as they decompose organic matter. Eventually oxygen is depleted in the bottom waters. Low dissolved oxygen in the bottom waters can lead to a release of nutrients from the lake sediments.

Dissolved oxygen was also measured at every meter throughout the Echo Lake water column in 2015. Oxygen levels were relatively high in the upper waters throughout the summer. From May through August, there was a sharp increase in dissolved oxygen levels between about 10 and 20 feet deep. This indicates vigorous algae growth at that depth which added oxygen to the water. Meanwhile, the bottom waters contained much less dissolved oxygen, and oxygen levels declined through the summer. There was little or no oxygen in the water below about 20 feet. During the summer period, oxygen in the lower waters is consumed by the decomposition of organic material within the lake. When the lake is stratified, the oxygen is not replenished by the overlying oxygen-rich upper waters or the atmosphere. The bottom of the lake will remain devoid of oxygen until the lake mixes (typically in late October/early November). The lake then remains mixed until springtime when the upper waters begin to warm and dissolved oxygen begins to decline in the bottom.

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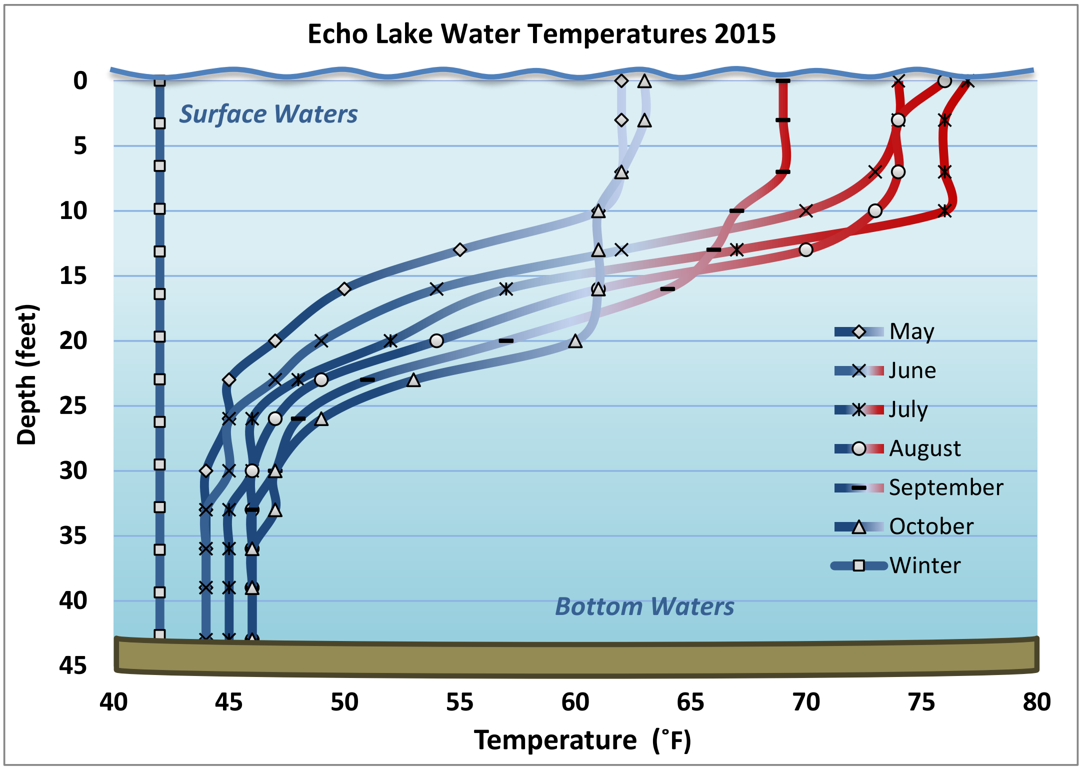
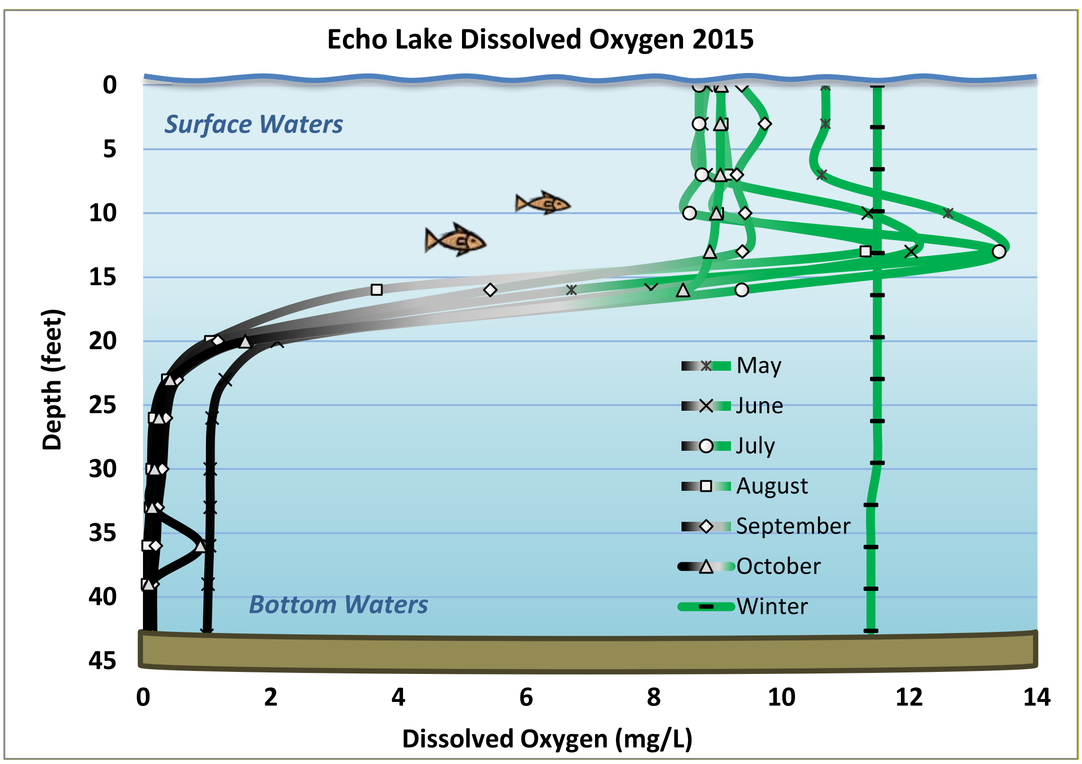

Echo Lake Water Temperatures 2015
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
25
30
35
40
45
40
45
50
55
60
65
70
75
80
Temperature (˚F)
May
June
July
August
September
October
Winter


Echo Lake Dissolved Oxygen 2015
Surface Waters
Bottom Waters
Depth (feet)
0
5
10
15
20
25
30
35
40
45
0
2
4
6
8
10
12
14
Dissolved Oxygen (mg/L)
May
June
July
August
September
October
Winter

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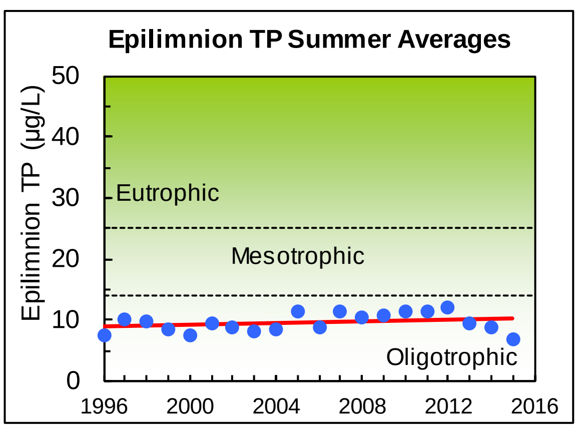
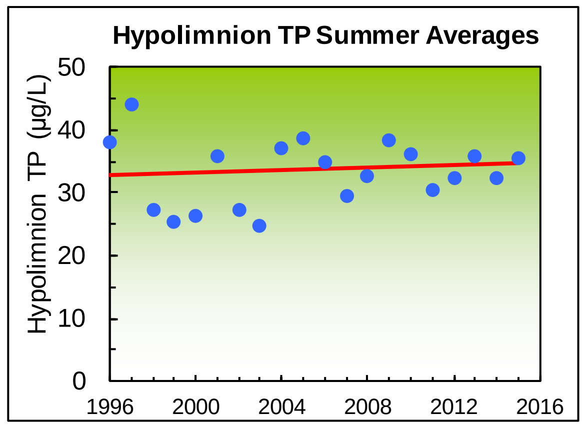
Phosphorus (key nutrient for algae)

Nutrients are essential for the growth of algae, fish, and aquatic plants in a lake. However, too many nutrients, especially phosphorus, can pollute a lake and lead to unpleasant algae growth. Nutrients enter the lake through stormwater runoff or from streams flowing into the lake. Sources of nutrients include fertilizers, pet and animal wastes, poorly-maintained septic systems and erosion from land clearing and construction. Monitoring of phosphorus levels over time helps to identify changes in nutrient pollution.

Total phosphorus concentrations in the epilimnion (upper waters) are low. The 1996 – 2015 long-term summer average for phosphorus is 10 µg/L (micrograms per liter, which is equivalent to parts per billion). Although there has been little year-to-year variability in phosphorus levels over time, there was a small, but statistically significant, trend toward higher phosphorus in the upper waters through 2014 ($p=0.08$). However, that trend disappeared in 2015 with a summer average of 6.7 µg/L. More phosphorus can lead to more algae growth, which is reflected in the higher chlorophyll *a* levels described below.



Phosphorus values in the hypolimnion (bottom waters) are higher and more variable than in the epilimnion. The long-term summer average is 33 µg/L. Summer phosphorus averages have ranged from 25 µg/L in 1999 and 2003 to 44 µg/L in 1997. There is no statistical evidence of a significant trend in total phosphorus levels in the bottom waters between 1996 and 2015. However, any increases in phosphorus concentrations in the bottom waters would indicate a build-up of nutrients in the lake sediments that might be a sign of accelerating eutrophication.



Chlorophyll a (Algae)

Algae are tiny plant-like organisms that are essential for a healthy lake. Fish and other lake life depend on algae as the basis for their food supply. However, excessive growths of algae, called algae blooms, can cloud the water, form unsightly scums, and sometimes release toxins. Excess nutrients, such as phosphorus and nitrogen, are the main cause of nuisance algae growth in a lake. Chlorophyll *a* measurements are one method for tracking the amount of algae in a lake.

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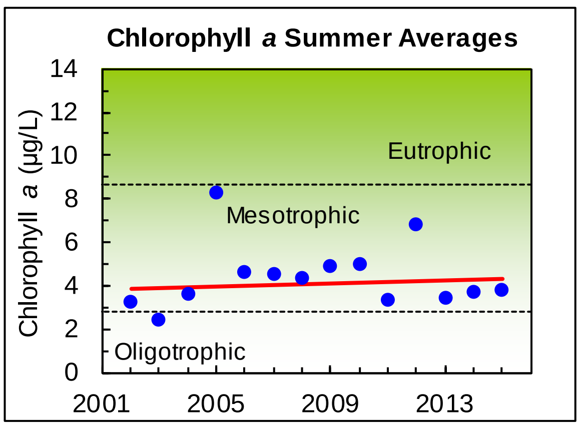
Chlorophyll *a* values showed moderate algae levels in Echo Lake in the summers of 2002 - 2015. The long-term summer average over these years is 4.5 µg/L. The summer average for 2005 was substantially higher, mainly because of one very high measurement in September taken during a dense algae bloom. In 2012, the summer average was also substantially higher than the long-term average at 6.8 µg/L. Even though there has not been a statistically significant increasing trend, there do appear to be higher chlorophyll *a* averages in some years. This corresponds with increasing phosphorus levels in the upper waters, but is at odds with improvements in water clarity.



Nitrogen (another essential nutrient for algae)

Nitrogen is another important nutrient for plant and algae growth. Similar to phosphorus, lakes with high levels of nitrogen typically have more aquatic plants and algae. In 2014 and 2015, Echo Lake had moderate levels of total nitrogen (summer average of 416 µg/L). This is consistent with the moderate chlorophyll *a* concentrations measured in the lake.

The relative abundance of nitrogen and phosphorus can also be a useful indicator of lake conditions. This is referred to as the nitrogen to phosphorus ratio or N:P ratio. When lakes have low N:P ratios (typically less than 20), algae growth is often high and harmful blue-green algae blooms may be a problem. Low N:P ratios may also indicate that fertilizers, septic systems, polluted runoff from developed areas, and release of phosphorus from the lake bottom sediments are contributing most of the nutrients to the lake.

In contrast, when lakes have higher N:P ratios (greater than 20), algae growth will be limited by the amount of phosphorus available, and blue-green algae are usually less of a problem. Echo Lake had a relatively high average N:P ratio of 59, and no blue green algae blooms were observed in 2015.

Aquatic Plants

Aquatic plants are also important in a lake ecosystem. Plants provide food and shelter for fish and other aquatic animals, stabilize the shoreline and bottom sediments, and in some cases increase water clarity by out-competing algae for nutrients. Some plants grow entirely submersed under the water (like elodea), some have leaves that float on the surface (like lilies), and others have roots under the water with most of the plant standing above the water (like cattails).

Although aquatic plants are essential for lake health, excess growth of aquatic plants can interfere with swimming, boating, fishing, and wildlife habitat. In addition, invasion by non-native plant species can seriously damage a lake ecosystem. Non-native aquatic plants choke out native plants and form dense stands that are a nuisance to humans and wildlife.

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Echo Lake has a diversity of emergent and submersed aquatic plants typical of other lakes in Snohomish County. Most of the aquatic plants are native to this area. However, in September 2010, the volunteer lake monitor at Echo Lake reported a new plant growing near the public boat launch. The plant was identified as *Marsilea mutica*, a water clover from Australia. This plant is beautiful, but is an aggressive invader that can spread rapidly in the lake and cause problems with boating and fishing. The plant likely came from someone's aquarium dumped in the lake.

In 2011, Snohomish County SWM and volunteers worked to eradicate the plants using bottom barriers. The barriers were composed of black landscaping fabric that was secured to the lake floor with large rocks in order to prevent the growth of the water clover. The barriers were improved and adjusted in 2012 because *Marsilea mutica* was still able to grow along the edges and gaps of the fabric barriers. There was very little evidence of any *Marsilea mutica* growing since 2013, but the barriers were left in place. Future efforts will continue to ensure that the plants are completely eradicated.

SHORELINE CONDITION

The lake shoreline condition is important in understanding the overall lake health. Frequently, lake shorelines are modified through removal of natural vegetation, the installation of bulkheads or other hardening structures, and/or removal of partially submerged logs and branches. These types of alterations can be harmful to the lake ecosystem because natural shorelines protect the lake from harmful pollution, prevent bank erosion, and provide important habitat for fish and wildlife.

The Echo Lake shoreline is moderately developed with residential uses. There were 29 homes or cabins around the lake in 1973. By the mid-90s, there were 44 homes bordering the lake. There are also 37 docks present on the lake. Fortunately, there have been limited structural modifications to the shoreline. Only 33% of the shoreline has been modified with bulkheads, rock or log revetments, or fill. However, a large majority (87%) of the native vegetation immediately adjacent to the shoreline is no longer intact. In most cases, the native vegetation has been replaced by lawns down to the water. Lawns can be a source of nutrients and do not protect the lake as well as a buffer of native vegetation. Also, there are only a few pieces of large wood (about 10) still remaining in the lake. These old logs and branches are valuable for fish and wildlife habitat.

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SUMMARY

Trophic State

All lakes go through a process of enrichment by nutrients and sediment. In this process, known as eutrophication, nutrients and sediment contribute to the ever-increasing growth of algae and aquatic plants. Over thousands of years, lakes will gradually fill up with organic matter and sediments.

Lakes can be classified by their degree of eutrophication, also known as their trophic state. There are three primary trophic states for lakes—oligotrophic, mesotrophic, and eutrophic—as well as intermediate states. Oligotrophic lakes are usually deep, with clear water, low nutrient concentrations, and few aquatic plants and algae. Mesotrophic lakes are richer in nutrients and produce more algae and aquatic plants. Eutrophic lakes are often shallow and characterized by abundant algae and plants, high nutrient concentrations, limited water clarity, and low dissolved oxygen in the bottom waters.

The trophic state classification of a lake does not necessarily indicate good or bad water quality because eutrophication is a natural process. However, human activities that contribute sediment and excess nutrients to a lake can dramatically accelerate the eutrophication process and result in declining water quality.

Based on the long-term monitoring data, Echo Lake may be classified as mesotrophic, with moderate water clarity, low to moderate phosphorus, and moderate chlorophyll *a* concentrations.

Condition and Trends

Overall, Echo Lake is in good condition. The lake is meeting its water quality target calling for maintaining stable water clarity. The long-term average water clarity has increased in the last ten years from 3.7 meters to 3.9 meters, and there is a statistically significant trend toward improving water clarity.

However, the long-term averages for total phosphorus have increased slightly in recent years from 9 µg/l to 10 µg/l in the upper waters and from 32 µg/l to 33 µg/l in the bottom waters. Even though there is no statistical trends, there have also been higher chlorophyll *a* averages in some years, which indicates more algae growth in the lake.

For these reasons, Echo Lake is considered at risk of future water quality declines. The primary threat to maintaining good water quality in the lake is increases in nutrients from future development and from other human activities in the watershed. In order to protect the condition of the lake, measures to control nutrients in the watershed should be taken now. To find out more about the causes and problems of elevated lake nutrient levels and tips to improve lake water quality please visit www.lakes.surfacewater.info.

DATA SUMMARY FOR ECHO LAKE						
		Water Clarity (Secchi depth	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
Menasveta, 1961	**7/59**	2.9	-	-	-	-
Bortleson, et al, 1976	**8/3/73**	2.1	15	31	-	-
Volunteer	**1992**	2.8 - 3.8 (3.3) *n = 8*	-	-	-	-
Volunteer	**1993**	2.3 - 4.8 (3.6) *n = 12*	-	-	-	-
SWM Staff or Volunteer	**1994**	2.6 - 4.6 (3.6) *n = 12*	-	-	-	2.4 - 5.9 (4.2) *n = 2*
SWM Staff or Volunteer	**1995**	2.2 - 3.4 (2.9) *n = 8*	-	-	-	9.9
Volunteer	**1996**	3.1 - 3.7 (3.3) *n = 3*	6 - 9 (8) *n = 2*	36 - 40 (38) *n = 2*	-	-
SWM Staff or Volunteer	**1997**	2.6 - 5.2 (3.7) *n = 8*	10 (10) *n = 2*	30 - 58 (44) *n = 2*	-	-
SWM Staff or Volunteer	**1998**	3.2 - 5.3 (4.5) *n = 7*	7 -13 (10) *n = 4*	21 - 40 (27) *n = 4*	-	-
SWM Staff or Volunteer	**1999**	3.5 - 4.0 (3.8) *n = 4*	7 - 9 (9) *n = 4*	24 - 26 (25) *n = 4*	-	-
SWM Staff	**2000**	3.9 - 4.3 (4.1) *n = 3*	7 - 8 (7) *n = 3*	21 - 32 (26) *n = 3*	-	-
SWM Staff	**2001**	3.8 - 5.5 (4.6) *n = 4*	7 - 13 (10) *n = 4*	31 - 41 (36) *n = 4*	-	-
SWM Staff	**2002**	3.2 - 5.0 (3.9) *n = 4*	7 - 11 (9) *n = 4*	24 - 32 (27) *n = 4*	-	1.3 - 4.8 (3.3) *n = 4*
SWM Staff	**2003**	3.5 - 5.4 (4.0) *n = 4*	8 - 9 (8) *n = 4*	23 - 28 (25) *n = 4*	-	0.8 - 5.3 (2.5) *n = 4*
Volunteer	**2004**	2.6 - 4.9 (3.2) *n = 8*	7 - 10 (9) *n = 4*	27 - 50 (37) *n = 4*	-	1.9 - 4.8 (3.6) *n = 4*
Volunteer	**2005**	2.8 - 5.1 (3.9) *n = 7*	10 - 13 (12) *n = 4*	23 - 59 (39) *n = 4*	-	3.7 - 20 (8.3)[a] *n = 4*

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DATA SUMMARY FOR ECHO LAKE						
		Water Clarity (Secchi depth	**Total Phosphorus (µg/L)**		**Total Nitrogen (µg/L)**	**Chlorophyll *a* (µg/L)**
Source	**Date**	**in meters)**	**Surface**	**Bottom**	**Surface**	**Surface**
Volunteer	**2006**	3.7 - 52 (4.4) *n = 9*	7 - 10 (9) *n = 4*	31 - 37 (35) *n = 4*	-	3.5 - 6.4 (4.6) *n = 4*
Volunteer	**2007**	3.1 - 4.0 (3.5) *n = 5*	9 - 15 (11) *n = 4*	21 - 36 (30) *n = 4*	-	3.2 - 6.4 (4.6) *n = 4*
Volunteer	**2008**	3.5 - 6.0 (4.6) *n = 6*	8 - 11 (10) *n = 4*	22 - 45 (33) *n = 4*	-	1.9 - 11 (4.4) *n = 4*
Volunteer	**2009**	3.4 - 4.4 (3.8) *n = 4*	9 - 13 (11) *n = 4*	30 - 50 (39) *n = 4*	-	2.4 - 8.8 (4.9) *n = 4*
Volunteer	**2010**	3.2 - 5.0 (4.0) *n = 7*	9 - 16 (12) *n = 4*	34 - 39 (36) *n = 4*	-	2.7 - 8.0 (5.0) *n = 4*
Volunteer	**2011**	3.6 - 5.9 (4.7) *n = 7*	9 - 14 (11) *n = 4*	12 - 57 (31) *n = 4*	-	1.5 - 6.7 (3.4) *n = 4*
Volunteer	**2012**	4.1 - 5.2 (4.8) *n = 5*	9 - 15 (12) *n = 4*	9 - 54 (33) *n = 4*	-	1.9 - 12 (6.8) *n = 4*
Volunteer	**2013**	3.2 - 4.6 (4.0) *n = 11*	6 - 11 (9) *n = 4*	31 - 40 (36) *n = 4*	-	1.5 - 6.4 (3.4) *n = 4*
Volunteer	**2014**	*3.0 - 5.2* *(4.1)* *n = 12*	*7 - 10* *(9)* *n = 4*	*27 - 43* *(33)* *n = 4*	*310 - 645* *(445)* *n = 4*	*2.4 - 5.9* *(3.7)* *n = 4*
Volunteer	**2015**	3.2 - 5.2 (3.9) *n = 10*	4 - 9 (7) *n = 6*	30 - 46 (36) *n = 6*	294 - 516 (393) *n = 5*	2.7 - 4.8 (3.8) *n = 6*
Long Term Avg		**3.9** **(1992-2015)**	**10** **(1996-2015)**	**33** **(1996-2015)**	**416** **(2014-2015)**	**4.5** **(2002-2015)**
TRENDS		**Increasing**	**None**	**None**	**NA**	**None**

NOTES

- Table includes summer (May-Oct) data only.
- Each box shows the range on top, followed by summer average in ( ) and number of samples (*n*).
- Total phosphorus data are from samples taken at discrete depths only.
- "Surface" samples are from 1 meter depth and "bottom" samples are from 1-2 meters above the bottom.

[a] Average is influenced by one high value.